EVALUATE THE EFFICACY OF ALTERNATE NEMATICIDE, FUNGICIDE AND NITROGEN ENHANCING PRODUCTS IN PINEAPPLE CROPS

Research Topic 4: Pest Management

Trial number: 04-WB-06

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INTRODUCTION

Pineapples are affected by a variety of pests including insects, diseases, nematode and weeds. Soil types, climatic factors, crop stages and crop management practices affect the intensity of pest infestations. An integrated approach comprising cultural, mechanical, biological and chemical measures are most commonly used in managing these pests. The primary goal is to keep pest populations below economic threshold levels to avoid serious crop losses.

Biofilm Crop Protection is a microbial biotechnology company that developed products to target pests and diseases of economic importance. This trial evaluates a number of Biofilm products that focus on managing nematodes, phytophthora root rot and enhancing of nitrogen.

HYPOTHESIS

Selected Biofilm products will suppress nematodes and Phytophthora root rot and improve the efficiency of the applied nitrogen fertiliser.

OBJECTIVE

This exercise will evaluate a number of Biofilm products on the management of nematodes and phytophthora root rot and will increase the efficiency of nitrogen fertiliser use by pineapples compared with traditional mineral fertilisers.

More specifically:

1) To observe the effects of biological nematicide and fungicide products on pineapple root health to improve soil and plant biology.
2) To observe the effects of nitrogen enhancing products on pineapple crop growth.
3) To undertake a cost analysis of the experimental program compared with standard practices.
4) To investigate any yield improvements at plant crop harvest.

METHOD

Location and grower

The demonstration site was undertaken in collaboration with Littabella Pines located in Yandaran Queensland. The farm owners John and Linda Steemson have been growing pineapples in the area since 2004 and have farmed sugarcane and other small crops in the Yandaran for two generations.

Figure 1: Demonstration trial site map.

Dates

- January 2019 - treatments planned and site selected.
- March 2019 - soil nutritional analysis.
- April 2019 - pre-plant treatments applied and site planted.
- July 2019 - crop health assessment.
- September 2019 to April 2020 - post plant treatments applied.
- November 2019 - crop health assessment.
- April 2020 - crop health assessment.
- October 2020 - crop health assessment.
- February 2021 - plant crop harvest

Crop details
The trial site followed a previous crop of Smooth Cayenne, which was taken to ratoon harvest. The previous crop was harvested in spring 2018 with major issues of *Phytophthora* root rot, nematode and white grub.

The soil was prepared to standard industry conditions with good soil tilth, no crop residue and good soil moisture with a soil pH of 4.2. Weather leading up to application was relatively dry with temperatures ranging from 20 – 30°C. The site was planted with Smooth Cayenne and the 73-50 variety.

Description
The demonstration trial was established in January 2019 amidst a five-year drought, only one third of average rainfall was received. The pre-plant treatments were applied directly to the ground via a boomspray attached to a rotary hoe and incorporated immediately. The site was then bed formed and planted within 1 day of application. The post-plant treatments were applied every 12 weeks as recommended by the Biofilm representatives. Each treatment was one hectare in size.

The demonstration trial compared a standard practices treatment (control) with an experimental treatment. The experimental treatment applied a combination of products which Biofilm claimed to have properties that would help to manage nematodes and root rot and it also included a nitrogen product claimed to increase nitrogen use efficiency. An application of chicken manure was also included. See below for the pre- and post-plant application details.

Biofilm selected the products to be used based on their theoretical effectiveness for pineapple.

Standard Program
Field 2A: 73-50
Field 2B: Smooth Cayenne

The standard industry treatment used the pre-plant and post-plant fertiliser and pesticide program as described in the pineapple Best Practice Manual.

Pre-plant applications were incorporated into the soil with a rotary hoe, this consisted of:
- 2.2kg /ha Bromacil
- 2.0L/ha Bifenthrin
- 2.0L/ha Metalaxyl

Post-plant foliar applications were applied every 12 weeks, this consisted of:
- 2.0L/ha Metalaxyl
- 2.0L/ha Bifenthrin

Experimental Program
Field 1A: 73-50
Field 1B: Smooth Cayenne.

Pre-plant application (incorporated into the soil with a rotary hoe and 500L water per hectare before planting):

- 5 tonnes/ha composted chicken manure
- RhizoMax® - 20L/ha
- Nematamax® - 50L/ha
- Squadron® - 20L/ha

Post-plant application (foliar drench of 5,000L water per hectare applied every 12 weeks):

- RhizoMax® - 60L/ha
- Nematamax® - 150L/ha
- Squadron® - 60L/ha
- Tri Fix N® - 1.5kg/ha
- Hatake® - 3.5kg/ha

Details of products used in experimental program

Nematamax® - a biological inoculant containing a strain of naturally occurring entomopathogenic fungus. The fungus acts by infecting, parasitizing and killing eggs, juvenile and adults of most nematode species.

Squadron® - contains bacteria which it is claimed protect plants from pathogens by rapidly colonising the rhizosphere on the roots.

Rhizomax® - a selective strain of a *Bacillus* species which is claimed to provide effective management of a wide range of fungi and bacteria.

Trifix N® - three naturally occurring endophytic bacteria which are claimed to enhance fertiliser efficiency by improving nutrient uptake and utilisation by the crop through increased nitrogen fixation and improved uptake of applied nitrogen. Also claim to improve root development, plant health and ability to cope with stress.

Hatake® - *Bacillus amyloliquefaciens* strain claimed to have excellent plant pathogen fighting ability and enhance degradation of organic matter.

Metalaxyl was removed from the experimental program pineapple operation but it received 5 tonnes/ha composted chicken manure and Trifix N and Hatake to improve the efficiency of the urea.

The standard treatment had 600kg/ha Calcipril as pre-plant fertiliser.

In both standard and experimental practice, the post plant foliar program consisted 50 - 120kg/ha urea, 60-150kg/ha potash and 25-50kg/ha magnesium sulphate applied monthly.

RESULTS

Crop health and pest and disease assessments were undertaken for both experimental and standard industry programs on both varieties. Refer to Figures 2 to 12. Root health ratings consisted a visual observation of root volume, fine feeder roots, damaged roots from

phytophthora root rot and nematode (galls and branching). The rating system had a range of 0 – 5 with 0 indicating no damage and 5 high level damage. Observations are described below.

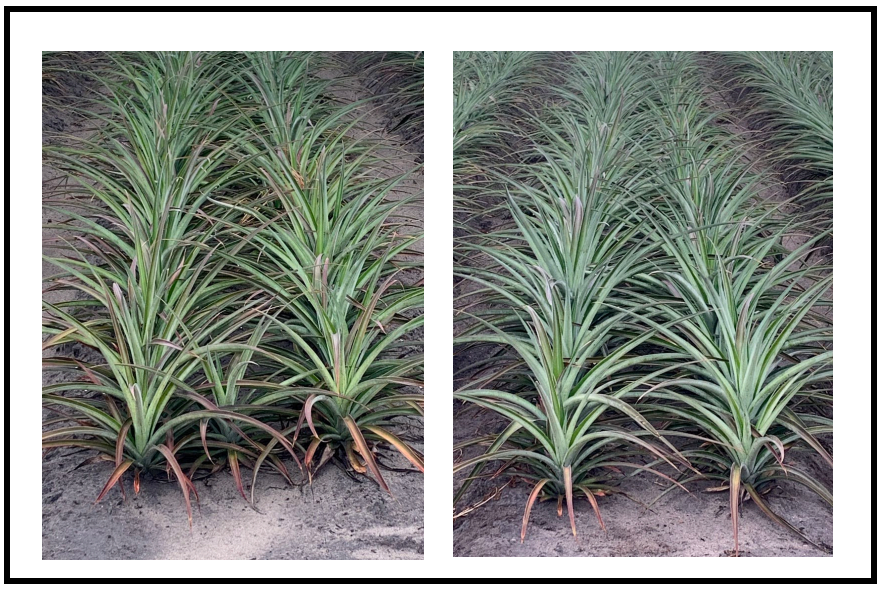
Three months after planting

- There were small variations in total plant weight between experimental and standard practices.
- There were quite large differences in root growth (root number and root length) in both Smooth Cayenne and 73-50 treatments compared with standard practices.
- There were minimal signs or symptoms of *Phytophthora* root rot, nematode or insect damage across any of the treated or standard practices plots at this stage.
- There were no visible differences in colour or general health of the plants.

Figure 2: Demonstration site three months after planting.

Six months after planting

- was little variation in plant growth between treatments.
- In 73-50 there was significantly better plant and root growth in both treatments.
- In Smooth Cayenne there were quite noticeable enhancements in root growth in the experimental treatment.
- Damage symptoms from Phytophthora root rot and nematodes increased across both varieties and treatments.
- The experimental treatment had less damage from Phytophthora root rot across both varieties.
- In general, the colour and general health of the in the experimental treatment was better.



Refer to Figure 3: Six months after planting: 73-50 73:50 – Standard treatment (left), 73-50 73:50 – Experimental treatment (right).

Twelve months after planting

- There was a noticeable difference in plant health between the experimental treatment and standard practice. In both varieties the experimental treatment appeared better (colour, root health).

- Generally there was more root growth in the experimental treatment for both varieties.

Figure 4: Twelve months after planting with natural fruit on headland: 73-50 73:50 – Standard treatment (left), 73-50 73:50 – Experimental treatment (right).

Figure 5: Twelve months after planting: Smooth Cayenne – Standard treatment (left), Smooth Cayenne – Experimental treatment (right).

Twenty four months after planting

- Total plant weight was similar between standard and experimental treatment in the Smooth Cayenne variety. The 73-50 plants in the experimental treatment had substantially more plant weight than those in the standard treatment. This was the result of earlier and more developed suckering in the 73-50 experimental treatment.

- Root volume and mass across both Smooth Cayenne and 73-50 varieties and between treatments were similar.

- Nematode and Phytophthora root rot were similar across both Smooth Cayenne and 73-50 and between treatments.

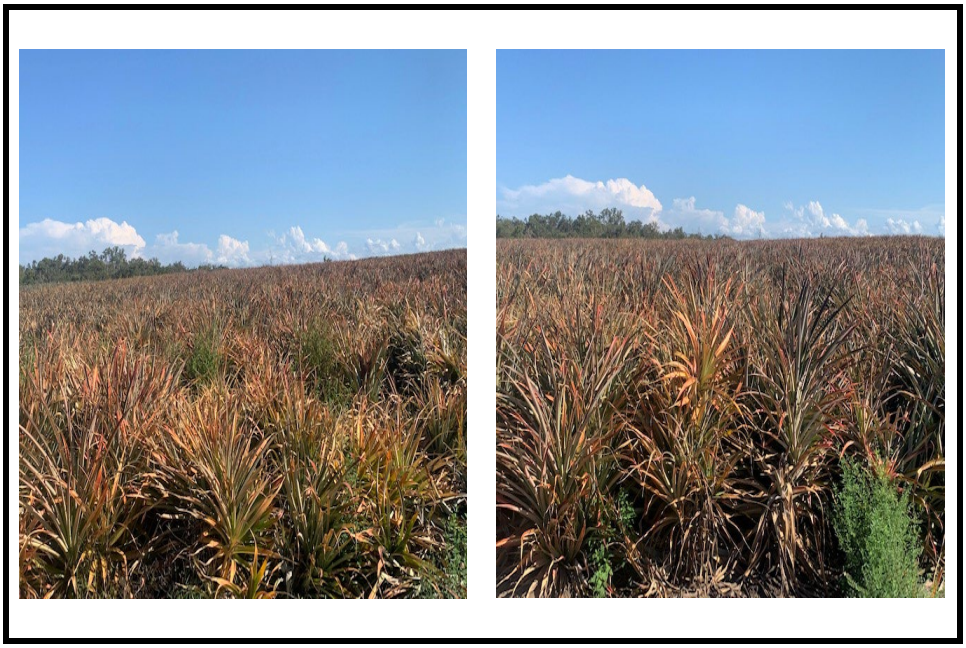


Figure 6: Twenty-four months after planting: 73-50 73:50 – Standard treatment (left), 73-50 73:50 – Experimental treatment (right).

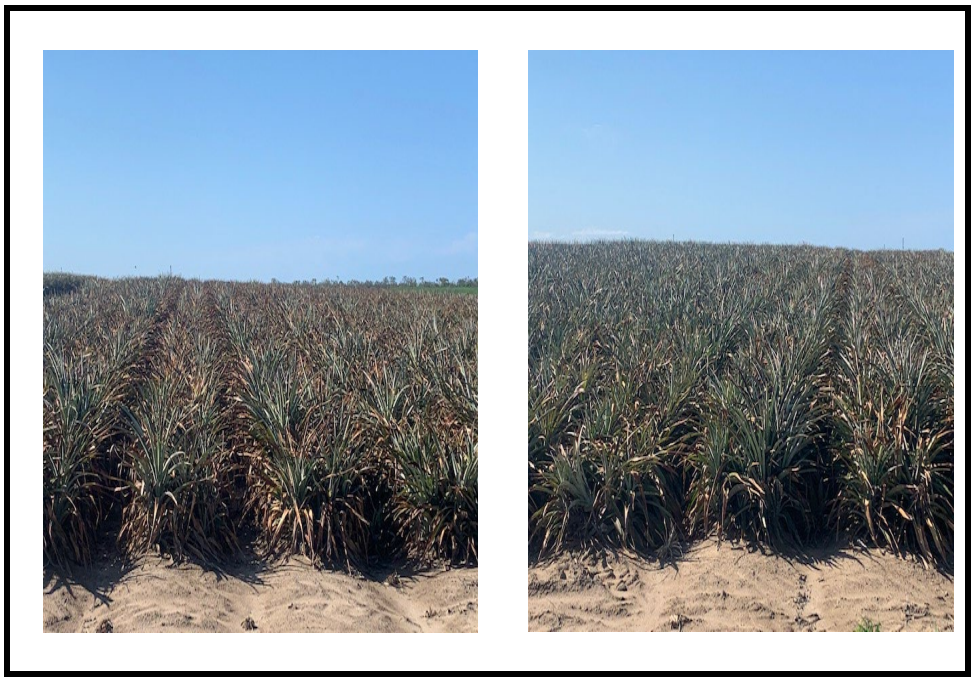


Figure 7: Twenty-four months after planting: Smooth Cayenne – Standard treatment (left), Smooth Cayenne – Experimental treatment (right).

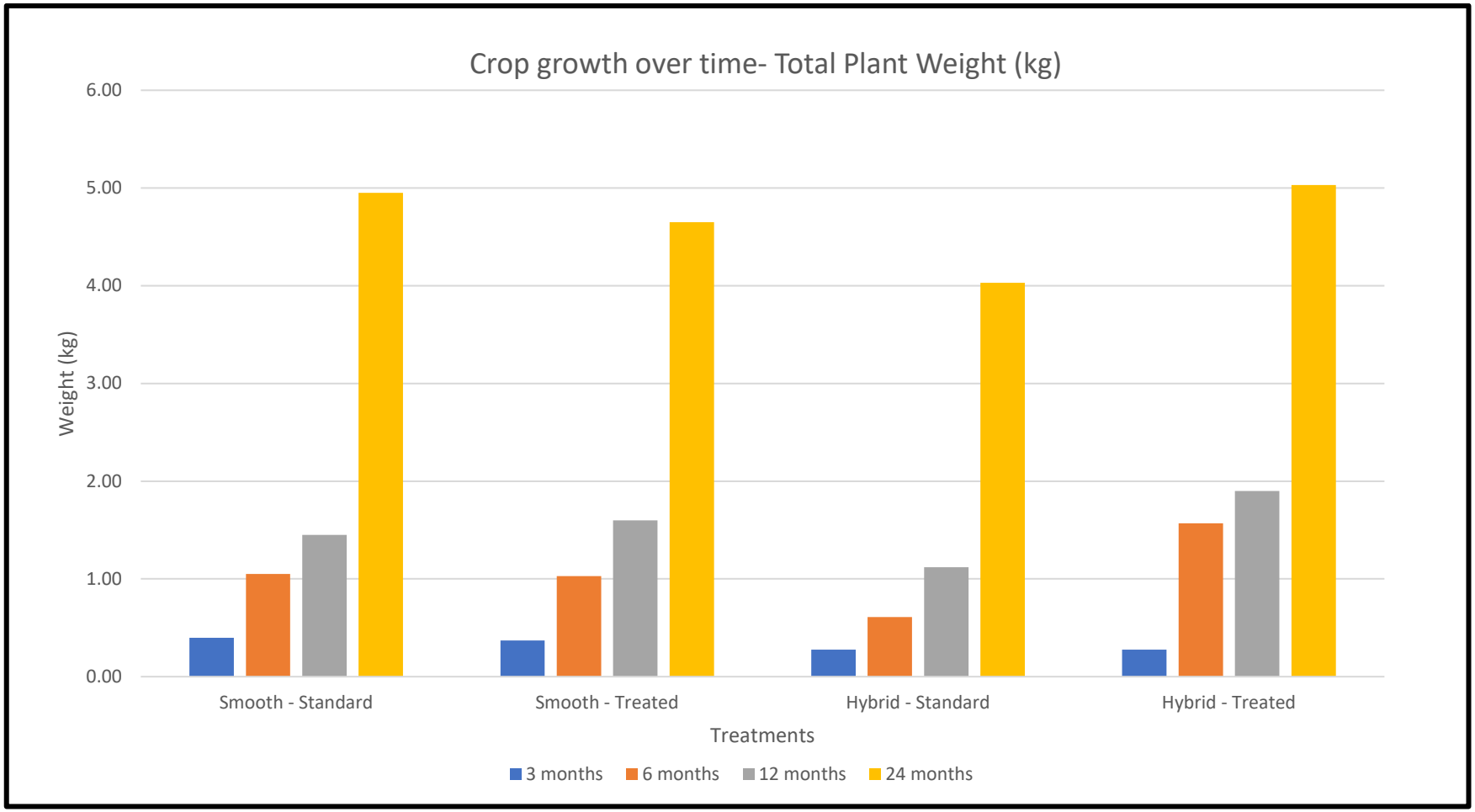


Figure 8: Crop growth assessment – total plant weight (kg).

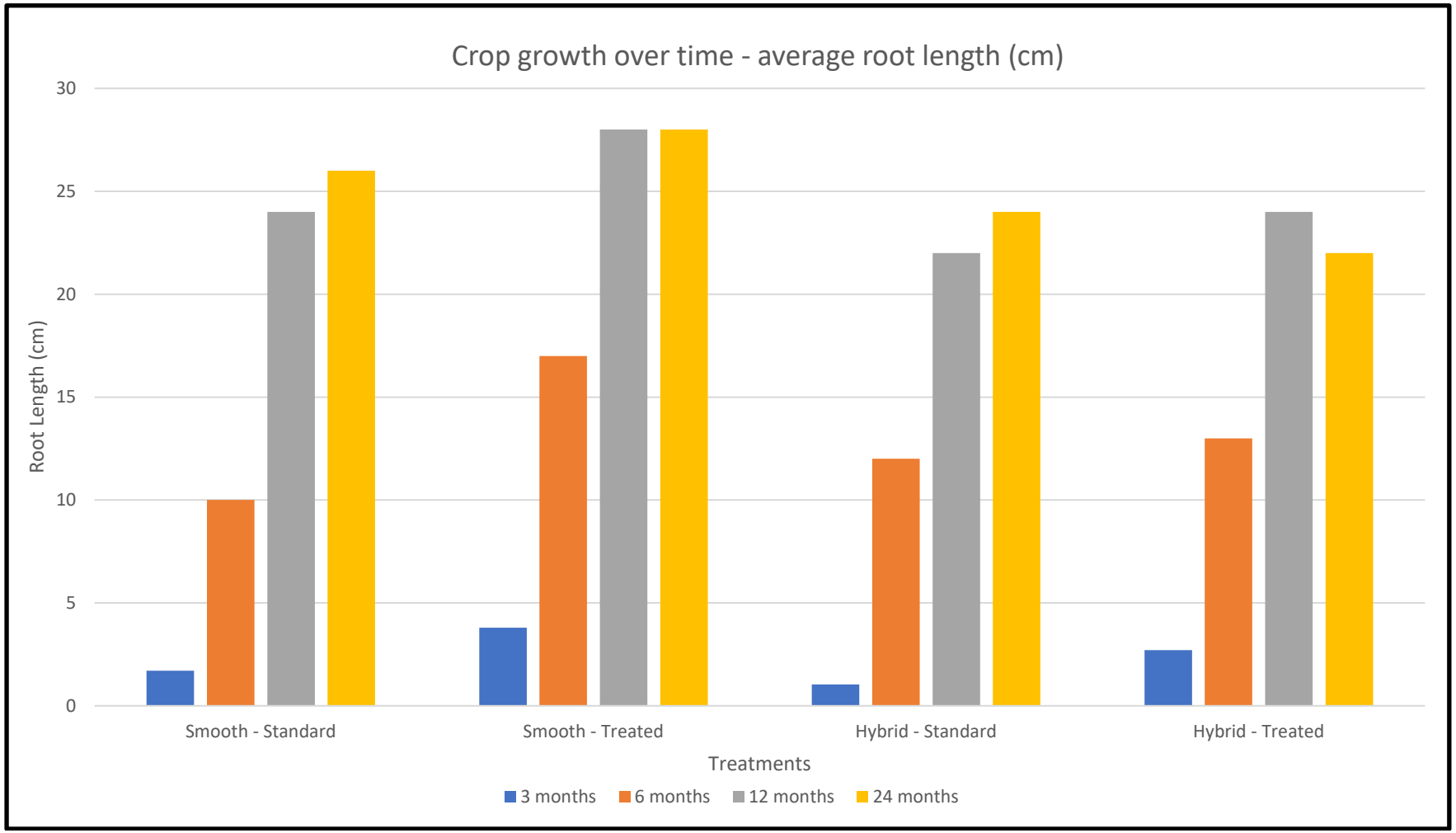


Figure 9: Crop growth assessment – average root length (cm).

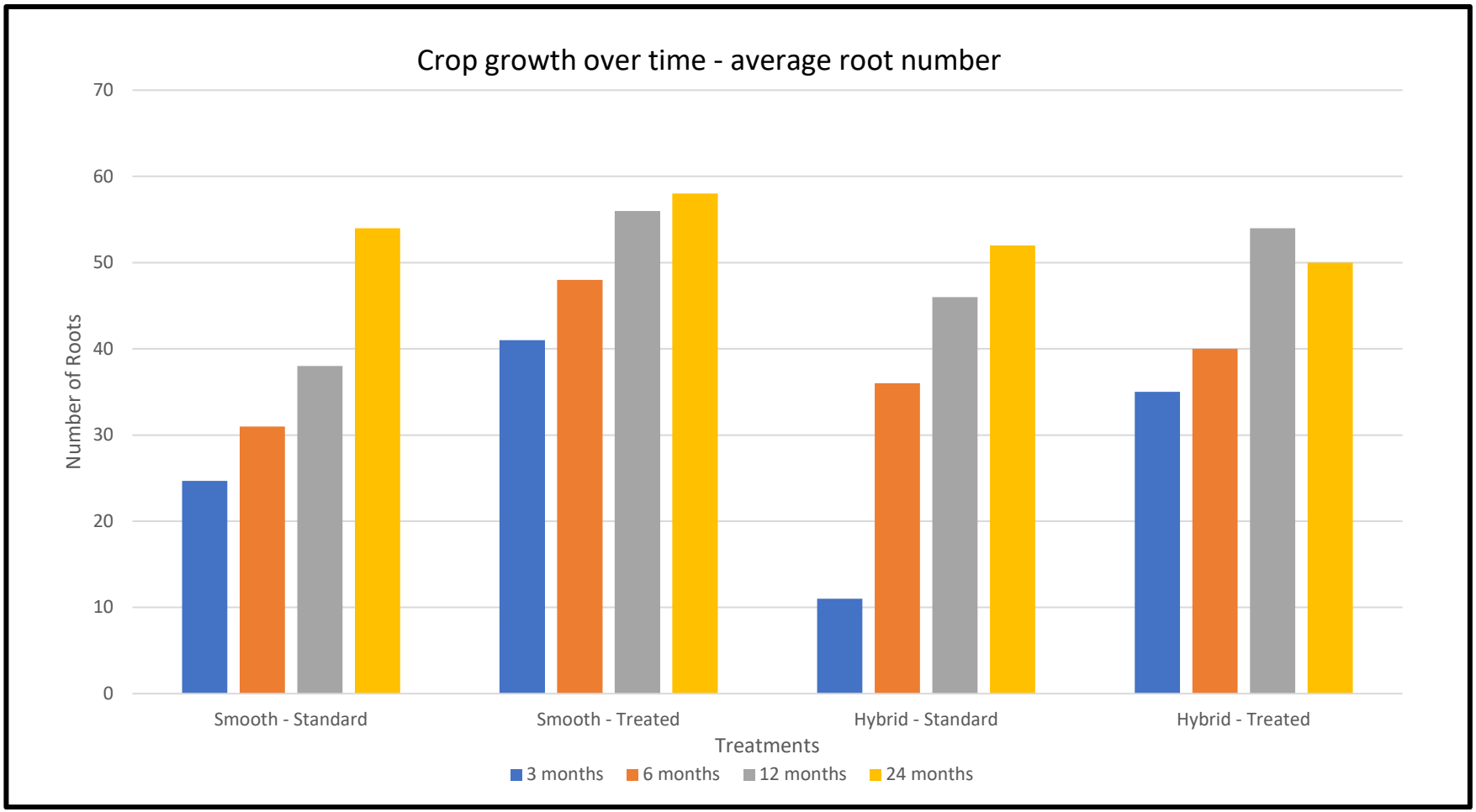


Figure 10: Crop growth assessment – average root number.

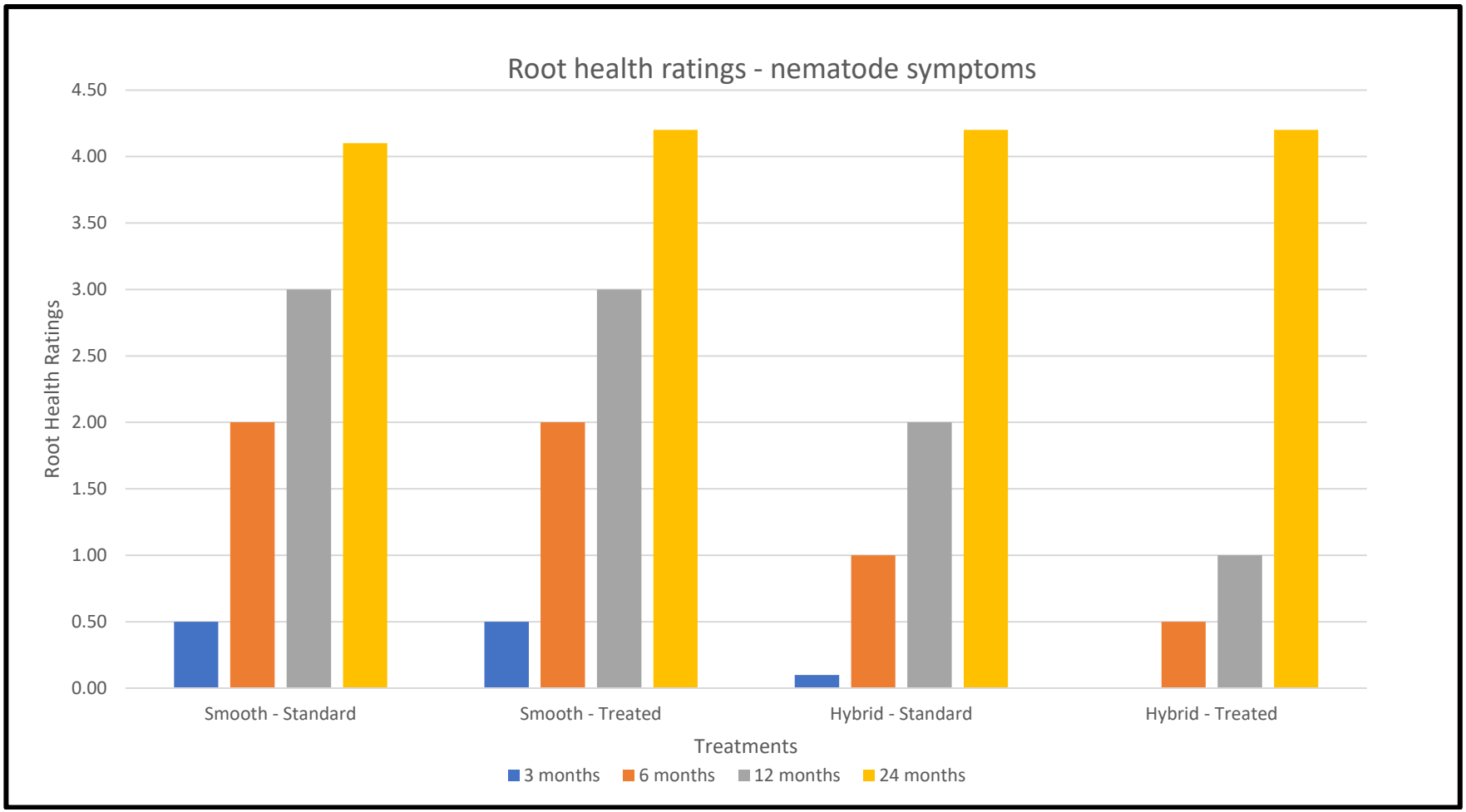


Figure 11: Root health ratings – nematode symptoms.

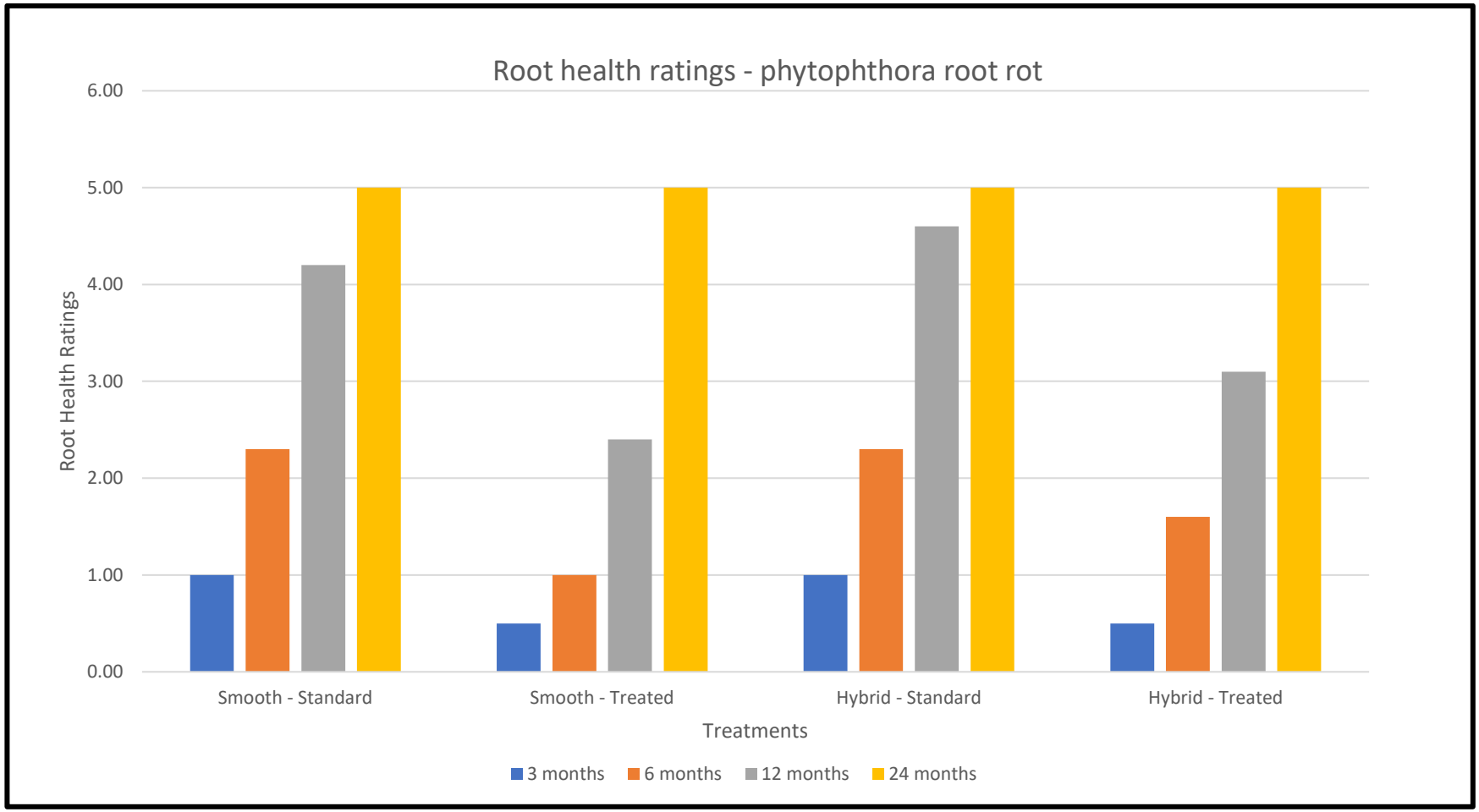


Figure 12: Root health ratings – phytophthora root rot symptoms.

Harvest Data – Plant Crop

Harvest data was collected from approximately 4,000 plants in total from four randomly selected sites within each treatment. The fruit from each site were harvested over several passes and for each pass the fruit was counted and weighed.

In February 2021, the plant crop for Smooth Cayenne was completely harvested. For 73-50 a large natural flowering crop was harvested in February, the rest was harvested though autumn 2021. The extrapolated harvest results are presented in Table 1. Yield information is based on a plant density of 54,000 plants per hectare and a grower return of $600 / tonne (farm gate) for the processing market.

DISCUSSION

Nematode and phytophthora root rot pressure at Littabella Pines is generally high across the farm. In addition to the common root knot nematode, the less common reniform nematode (normally confined to tropical areas) is found on the farm.

Throughout the life of this trial the area was experiencing drought conditions receiving only 30% of its average rainfall. Field conditions at planting were extremely dry and as a result there were major issues across the whole farm including limited root establishment and growth. This was exacerbated by extreme temperatures throughout the spring and summer seasons.

The demonstration trial compared standard practices treatment with an experimental treatment. The experimental treatment applied a combination of products which Biofilm claimed to have properties that would help to manage nematodes and root rot as well as a nitrogen product claimed to increase nitrogen use efficiency. These products were applied pre and post-planting and in addition chicken manure was applied to the same treatment.

Crop and root growth

Smooth Cayenne

Plant growth was similar between the experimental and standard program

Root health observations indicated for the experimental program the root volume was greater with more average roots per plant and better root length. The root establishment was substantially faster in the first twelve months but were similar to the standard program at crop plant crop harvest.

73-50

Crop growth was twenty percent higher in the experimental treatment compared with the standard treatment. For root health, similar trends as Smooth Cayenne were observed but the differences in the experimental and standard program were less for average root number and average root length.

Root health

Results were similar for both varieties. There was little difference in root health observations for nematode and phytophthora between treatments although in some instances it was worse in the experimental program. For phytophthora root rot the replacement of the

fungicide Metalaxyl™ in the experimental program reduced overall root health in both varieties. Nematode symptoms were higher in the 73-50 compared with Smooth Cayenne, this is a common observation in the industry.

Economics and yield

Crop yield and cost analysis were undertaken for both experimental and standard industry programs for 73-50 and Smooth Cayenne varieties.

Table 1: Harvest yield and grower return per hectare for each treatment

Treatment	Variety	Yield (t/ha)	Return	$ difference from Standard
Experimental	Smooth Cayenne	92.50	$ 55,497	+$8,398
Standard	Smooth Cayenne	78.50	$ 47,099	
Experimental	73-50	61.48	$ 36,887	-$6,205
Standard	73-50	71.82	$ 43,091	

Smooth Cayenne

For the Smooth Cayenne the experimental program yielded 92.50 tonnes per hectare and standard program 78.50 tonnes per hectare a difference of 14 tonnes per hectare or 15.14% improvement. Based on an average grower return of $600 per tonne farm gate, the experimental program generated $55,497 per hectare and the standard program $47,099 per hectare a difference of $8,389 per hectare (see Table 1).

73-50

For the 73-50 variety the experimental program yielded 61.48 tonnes per hectare and standard program 71.82 tonnes per hectare a difference of 10.34 tonnes per hectare or 14.40% reduction. Based on an average grower return of $600 per tonne farm gate, the experimental program generated $36,887 per hectare and the standard program $43,091 per hectare a negative difference of $6,205 per hectare (see Table 1).

The total costs of the experimental program were $4,368.11 per hectare (see Table 2) which included the products only. The products were applied with standard pre-plant and post plant fertiliser applications therefore had no additional practices or costs of application required.

Table 2. Total cost of experimental treatment per hectare

Product	Total applied (pre- and post-plant)	Total cost
Rhizomax®	80 L	$ 633.60
Nematamax®	200 L	$ 2,400.00
Squadron®	80 L	$ 633.60
Composted chicken manure	5,000 kg	$ 410.00
TriFix N® / Hatake®	5 kg	$ 290.91
Total cost ($)		**$ 4,368.11**

For Smooth Cayenne, the experimental program generated an additional return of $8,398 per hectare and accounting for the cost of the experimental products of $4,368 per hectare, there was a net gain of $4,030 per hectare.

However, for 73-50 the experimental program crop yielded $6,205 less value per hectare than the standard treatment and accounting for the $4,368 cost of experimental products the grower would be $10,573 worse off per hectare. This can probably be attributed to the poorer control nematodes and phytophthora root rot.

ADOPTION AND IMPACT

Historically, root health was a major discussion point in the pineapple industry but it has lost momentum in the last few years. Recently a number of root stimulant products have entered the market and shown to have potential. This has reignited interest in root health and its importance in sustaining pineapple yields. In addition, the popularity of nitrogen enhancing products have attracted interest given greater awareness of the environmental effects of nitrogen loss into waterways.

CONCLUSIONS

There is potential for some of the products in the experimental program to be useful tools in growing pineapples however because all these products and the chicken manure were included in the same treatment it is impossible to say which products were beneficial. Collaborative work with product company representatives, industry agronomists and growers to support further work may be useful.

ACKNOWLEDGEMENTS

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